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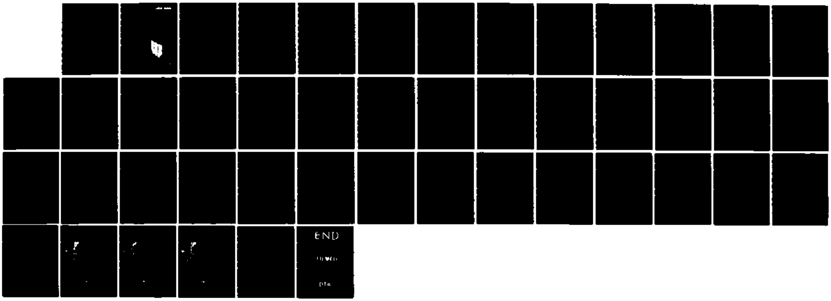

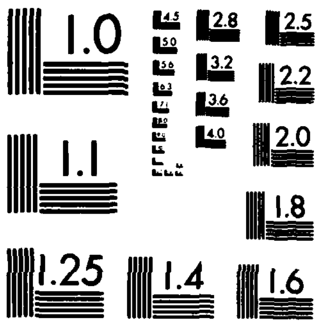

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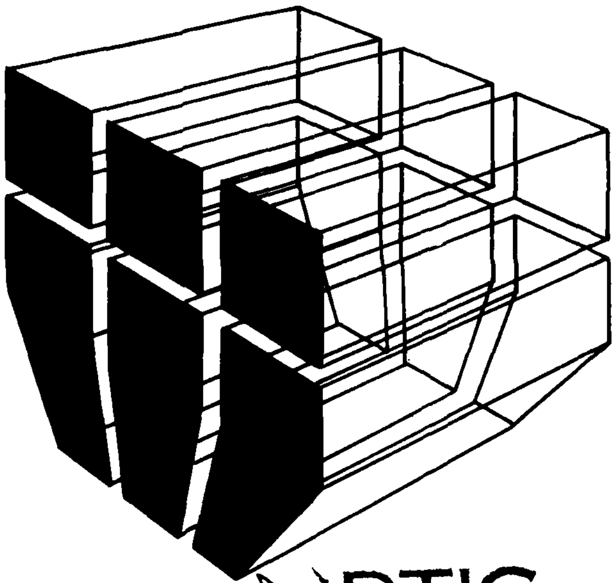
TECHNICAL REPORT P-85/10
April 1985

OBSTACLE PLANNING SIMULATION, VERSION 1.1:

Design and Performance Analyses

by
John M. Deponai III
James E. Snellen



Obstacle Planning Simulation (OPS) Version 1.1 is a pilot model developed to show the advantages of using simulation programs on PLATO to teach combat engineer tactics. Players in phase 1 of the game specify and implement an obstacle plan; in phase 2, players are passive observers as enemy mechanized infantry attack the friendly defensive position. The OPS design of Version 1.1 is described and its performance is analyzed. Recommendations are made on how to improve the model's performance and capabilities.

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FOREWORD

This work was done for the Assistant Chief of Engineers, Office of the Chief of Engineers (OCE), under Project 4A162731AT41, "Design, Construction, and Operation and Maintenance Technology for Military Facilities"; Task E, "Military Engineering"; Work Unit 048, "Computer Based Education Support." The applicable STO is 82-5:8. The OCE Technical Monitor was Dr. Clemens Meyer, DAEN-ZCM. The work was performed by the Facility Systems Division (FS) of the U.S. Army Construction Engineering Research Laboratory (USA-CERL). James E. Snellen and Steven L. Murray of the Microcomputer Systems Laboratory, University of Illinois, designed and programmed the MALOS simulation driver. The driver is the product of many years' experience by Dr. Snellen and was inspired by "Panzerkring," another PLATO-based war game which Dr. Snellen developed with David G. Anderer. James E. Snellen, Andrew S. Lavis, and Thomas E. Olson designed and developed the incremental/hidden movement system. Frank J. Mabry contributed significantly to the data base design and provided invaluable support to the MALOS project. Military subject matter consultation for the Obstacle Planning Simulation scenario was provided by experts at the U.S. Army Engineer School and by John Deponai and CPT Lynn Wahlgren of USA-CERL.

E. A. Lotz is Chief, USA-CERL-FS. COL Paul J. Theuer is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

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OBSTACLE PLANNING SIMULATION, VERSION 1.1: DESIGN AND PERFORMANCE ANALYSES

1 INTRODUCTION

Background

Obstacle Planning Simulation (OPS) Version 1.1 was developed as a pilot model to demonstrate the benefits of using simulation programs on PLATO to teach combat engineer tactics. OPS 1.1 is an interactive, map-based, two-phase video game for a single player that models the effects of combat engineer modifications to terrain via a limited set of obstacles. In phase 1, the player specifies and implements an obstacle plan of his/her own design in two to four blocks of time, each block representing 4 hr of real time in which to work on a barrier plan. In phase 2, the player becomes a passive observer as an enemy mechanized infantry division attacks the friendly reinforced mechanized infantry brigade defensive position the player has fortified. Combat outcomes are probabilistic and are influenced by the player-emplaced obstacles. Survivor numbers for each force type are displayed at the end of the game. A more complete description of the game is in the USA-CERL Technical Report *Obstacle Planning Simulation (OPS): Introduction and User Instructions.*[1]

Objective

Objectives of this report are to analyze the performance of OPS 1.1 and to recommend changes that would improve the model's usefulness as a teaching tool.

Approach

A description of the model's basic design was drawn from developmental work with the OPS 1.1. Twenty different attack/defend plans were run on the model and statistical results were assessed to find ways of improving this version.

Mode of Technology Transfer

OPS 1.1 is installed on the U.S. Army Engineer School (USAES) and University of Illinois (UI) PLATO systems. A MALOS simulation driver is being developed on the UI system as a vehicle for designing and running many different scenarios. Instructors at the USAES will design the different scenarios to support a variety of teaching points. This report identifies the changes to be made to the OPS 1.1 pilot model to achieve this capability. The OPS scenario will then become a single scenario residing in the MALOS simulation driver environment. The prototype MALOS simulation driver will be installed on the USAES system by September 1985.

2 DATA BASES REQUIRED

Terrain Definition

This data base assigns terrain attributes to each of 61 possible map cell displays. Twelve terrain attributes are modeled--three describing relative elevation (ground, slope, and hilltop) and nine describing terrain features (road, gully, woods, town, swamp, ford, water, clear, and bridge). Each map cell definition includes one elevation attribute and may also include one or

[1] John M. Deponai III and James E. Snellen, *Obstacle Planning Simulation (OPS): Introduction and User Instructions*, Technical Report P-85/08/ADA149468 (U.S. Army Construction Engineering Research Laboratory, January 1985).

more feature attribute(s). If a bridge or a town attribute is part of a map cell definition, a road attribute also must be included. Table 1 shows the attribute combinations allowed and the code numbers for each. Corresponding graphic symbols are shown in Table 2.

Movement Factor

MALOS assigns to each "piece type" (i.e., vehicle or person) a single "movement factor" value from a range of values, 0 through 12. This value determines the speed of the piece relative to other piece types. Movement factor values relate to a 12-increment, sequential, cyclical game clock. If a vehicle is assigned a movement factor of 12, it is credited with a "move impulse" in each of the 12 time increments per clock cycle (turn). If it is assigned a movement factor of 6, the vehicle is credited with a move impulse in each of 6 time increments per clock cycle. A piece assigned a factor of zero would not move at all. The movement factor data base identifies the clock increments in which move impulses are allowed for each movement factor value. The effect is a "top road speed" associated with each movement factor. For each movement factor, the Xs in Table 3 show during which clock increment a move impulse is allowed. In OPS Version 1.1, only vehicles assigned movement factors of 12 are used. Movement factors less than 12 would describe the movement characteristics of slower vehicles and people.

Movement Costs

For a piece to move from one map cell to another requires payment of a "base cost" of one move impulse. Additional move impulses are charged depending on the terrain attributes' cumulative effect, i.e., effects of the map cell from which the piece is moved plus those of the map cell to which the piece moved. Only move impulses defray movement costs, not all clock time increments. Movement cost data bases store the information needed to compute the additional cost, as measured in move impulses to move from one map cell to another due to terrain constraints. A separate table is required for each piece type since the terrain attributes' delay effect will vary with the type of piece being moved. Table 4 shows example movement cost values for the pieces used in OPS Version 1.1.

Thus, to move from a map cell with attributes (ground, woods, road) to a map cell with attributes (ground, ford, woods) would require a base cost of one move impulse plus three to move from woods to ford, plus five more to move from woods to woods, for a total of nine move impulses. The other attribute combinations result in "irrelevant" combinations that MALOS disregards. A piece with a movement factor of 9 could negotiate the move in one full clock cycle or turn, but a piece with a movement factor of 3 would require three full turns to negotiate the move. Similarly, to move from a map cell with attributes (ground, woods, road) to a map cell also with an attribute (slope) would require a total cost of 11 move increments, one for the base cost, five to move from ground to slope, and five to move from woods to slope. The other attribute combinations are irrelevant. If both map cells (i.e., those moved from and to) have a good attribute, only the base cost of one move impulse is required to move from the one cell to the other. However, if the cell being moved into has a from-to attribute combination rated "not allowed" in the movement cost table, MALOS does not permit such a move.

Engineer Reusable Asset Types

In OPS 1.1, six engineer reusable assets are defined. Table 5 lists codes for these assets. Certain assets types are assigned as having a "blade" capability.

Engineer Expendable Asset Types

In OPS 1.1 seven engineer expendable assets are defined. Table 6 lists the codes for these assets.

Engineer Task Types

Nine engineer task types are defined in OPS 1.1. Table 7 shows task codes for each and Table 8 shows corresponding resource requirements for each task.

Engineer Assets Available

Table 9 gives the total number of each type of engineer asset available, reusable and expendable, as used in OPS 1.1.

Weapons Types

One data base defines blue weapons systems and one defines red weapons systems. In OPS 1.1, three weapons systems are defined for the blue team: 105 mm, 25 mm, and TOW. Five weapons systems are defined for the red team: 125 mm, 73 mm, 14.5 mm, 12.7 mm, and AT-3.

Weapons Effectiveness

Probabilities of hitting a target (piece) in the open or in defilade and of killing each target, given that the target has been hit, are defined for each weapons system for multiples of some range increment up to a maximum range. The range increment is equal to the map cell length in meters. In OPS 1.1, for example, the range increment is 200 m. For each target type, MALOS computes a probability to kill a target as the product of the probability to hit the target and of the probability to kill the target given a hit for each firing weapons system, target type, exposure condition, and range. Table 10 gives the p(Hit) and p(Kill, given Hit) data bases for blue weapons against red targets. Table 11 lists resulting p(Kill) values computed by MALOS for the blue weapons systems; respective data for red weapons systems against blue targets are in Tables 12 and 13.

Piece Types

There is one data base for blue units and one for red units. Pieces can consist of people, wheeled or track vehicles, and artillery pieces. For each piece, a piece name is designated, both primary and secondary weapons systems may be assigned, a basic load for the primary weapons system is specified, and a movement factor is assigned. Table 14 shows the piece definition data used in OPS 1.1.

Orders of Battle

The order of battle data bases for the blue and red forces identify a collection of units. Each unit consists of three to seven subordinate units which, in turn, consist of 2 to 14 pieces. Each subordinate unit is identified by a letter image the size of a map cell on the screen display. All subordinate units belonging to the same parent have the same letter designation. Blue force units are companies with subordinate "sections" of two pieces each. Table 15 defines the blue order of battle used in OPS 1.1. Red force units are battalions with subordinate "companies" of 10 to 14 pieces each. Table 16 defines the red order of battle used in OPS 1.1.

Parameters

The following parameter values are used in OPS 1.1:

maxspd = 30 =	max speed of piece with movement factor of 12, in km/hr
mpmc = 200 =	meters per map cell
sbfr = 30 =	seconds between firing rounds, minimum required
minrnd = 2 =	minimum number of engineer work rounds
maxrnd = 4 =	maximum number of engineer work rounds
minkp = 5 =	minimum kill probability (percent) for a piece to fire on a target
ekp = 10 =	enhanced kill probability; percentage added to kill probability when a target is in a stopped state
resar =2500 =	reserve activation range; range in meters at which a red unit will trigger activation of a blue reserve unit

vebo = 3 = vehicles engaged by obstacle; number of vehicles subtracted from number of vehicles available to fire when unit is engaged in negotiating an obstacle

kpml = 4 = kills per mine level; number of enemy vehicles killed to reduce minefield by one AT-mine-density level if the minefield is coverd by fire (only one vehicle is killed, regardless of minefield density, if the minefield is not covered by fire)

minedly = 288 = base delay per AT-mine-density level, in seconds

atddly = 168 = base delay per antitank ditch, in seconds

rcdly = 144 = base delay per road crater, in seconds

abtdly = 888 = base delay per abatis, in seconds

urdly =1200 = base delay per urban rubble obstacle, in seconds.

In addition to the base amount of delay attributed to the various obstacles, the following "fire enhancement" additional delays also are counted as long as a particular obstacle is covered with fire:

fedm = 120 = fire-enhanced delay due to mines, in seconds

fedd = 120 = fire-enhanced delay due to ditch, in seconds

feda = 408 = fire-enhanced delay due to abatis, in seconds

fedu = 600 = fire-enhanced delay due to urban rubble, in seconds

fedc = 48 = fire-enhanced delay due to crater, in seconds.

3 TWENTY RUNS OF OPS 1.1: STATISTICAL ANALYSES

Attack Plans

Figure 1 shows the red force organization for combat. Five enemy attack plans are programmed into OPS 1.1. In all of the attacks, the enemy force first echelon consists of two BTR regiments that attack on line across a 10-km front. The enemy second echelon forces attack either in company columns or in companies on line. The scheme of each attack is represented in Figures 2 through 6 by a matrix that shows approximately where each enemy company enters the game board and its simulated time of arrival. In general, the strategy of each attack is as follows:

Attack A: heavy T-64 attack at the center; T-64s attack in column along two axes in center; BMPs attack in column at top of map.

Attack B: even pressure across whole front; T-64s attack on line at center and bottom; BMPs attack on line at top.

Attack C: same as Attack A, with one T-64 battalion shifted from center to bottom.

Attack D: heavy T-64 attack at top; T-64s attack in column at top part of map; BMPs attack in column at center; and a BMP battalion and two T-64 battalions attack in column at south.

Attack E: extremely heavy armor attack at center; T-64s and BMPs attack in column; light BMP and T-64 attack in the north and south.

Defense Plan

Figure 7 shows the blue force organization for combat and Figure 8 shows the blue force deployment for combat. Approximately two companies of mechanized infantry (M2s) are distributed evenly across the front in a picket line. Two companies of mechanized infantry

are distributed evenly down the left side of the map and are designated as reserve forces. (Reserve forces are not activated until all friendly forces in the same sector of fire are destroyed and/or enemy forces advance to within 2500 m of the reserves' position.) The balance of the friendly force--two companies of mechanized infantry, two companies of tanks (M1s) and two companies of ITVs--are distributed evenly across a defensive line west of the river. The M1s are deployed directly in front of the likely avenues of approach.

Levels of Engineer Effort

Four levels of engineer effort were used in statistical analysis of the game. The three barrier plans, designed by USA-CERL, should by no means be considered an "approved solution." They were created only for testing the model's performance on a representative set of data.

Level 1: base condition--no engineer effort expended.

Level 2: two engineer work periods--11 minefields (1-0-0 density), 6 antitank ditches, 9 blown bridges, 3 abatis, 4 road craters, and 10 M2 fighting positions on the picket line. Figure 9 shows the barrier and fortification locations for Level 2.

Level 3: three engineer work periods--Level 2 plus 6 minefields (1-0-0 density), 3 antitank ditches, 2 road craters, 3 M2 fighting positions on the picket line, and 2 M1 fighting positions on the main line of defense. Figure 10 shows the barrier and fortification locations for Level 3.

Level 4: four engineer work periods--Level 3 plus 6 minefields (1-0-0 density), 3 antitank ditches, 2 road craters, and 5 M1 fighting positions on the main line of defense. Figure 11 shows the barrier and fortification locations for Level 4.

Statistical Analysis

Using special programs to execute runs, gather data, and generate statistics, 100 runs of each attack plan/barrier plan combination were executed and the killed and survived data for each piece type were collected. Mean values and standard deviations for the data were computed and are shown in Tables 17 through 19. Table 20 shows the mean simulated time for running each attack against each barrier plan. Each table shows the percentage change from the base condition, i.e., no engineer effort expended. The results were somewhat surprising at first glance. For a particular attack plan, the number of blue force pieces killed would be expected to decrease as the level of engineer effort increases; however, this was not true in all cases. In Attack Plan A, the number of M2s killed increases with higher levels of engineer effort. The same is true of ITVs for Attack Plan B, barrier level 2. This result probably was produced when the barriers allowed temporary and local massings of enemy units that gave the enemy local fire superiority much greater than its average 4 to 1 overall superiority.

Some anomalies also appeared in the red force killed statistics. The number of red forces killed would be expected to increase as the level of engineer effort increases, but the number of T-64s killed actually declines for all levels of engineer effort in attack plan A, levels 2 and 3 of attack plan B, level 3 of attack plan C, and level 2 of attack plan E. The cause is similar to that stated above; i.e., by achieving a very high fire superiority at a given obstacle, the enemy probably neutralized the blue forces covering the obstacle and, therefore, the obstacle ceased to be effective. MALOS provides that minefields do not kill if they are not covered by friendly fire.

Performance Standards

For each piece type, blue and red, Table 21 presents the maximum number of kills for blue and the minimum number of kills for red expected for a particular engineer defense plan to be rated as having a significant impact on the battle's outcome. The numbers represent kills at 2.23 standard deviations from the mean kill figures for the "no engineer activity" level in Table 17.

4 FUTURE IMPROVEMENTS

Data Base Organization

As a demonstration model, OPS 1.1 is not set up to run a variety of scenarios. To be a useful teaching tool, the MALOS simulation driver must be constructed to allow the running of multiple scenarios designed to instill specific teaching points. Thus, OPS 1.1 represents use of the computer at one end of the teaching spectrum: at one end is a big "capstone" exercise, and on the other end are very simple "5-on-1" type scenarios designed to show the efficacy of using fighting positions, the utility of minefields, and so on. These would be run in a minute or two, versus the 15 to 20 min required to run OPS 1.1.

In OPS 1.1, the scenario map definition, the number of engineer assets available, the blue and red orders of battle, and the blue and red deployments are part of the scenario definition. All other data bases are part of the MALOS driver. In the future, for more flexibility in designing families of scenarios, only the data bases for terrain types definition, movement factor, and movement cost will reside as "givens" in the MALOS driver. All other data will be stored as part of the scenario definition.

Provision also will be made to design scenarios to run at different map scales. The OPS 1.1 scenario and the logic behind it are designed for scale 1:50,000. The weapons effectiveness tables will be reprogrammed to describe the ranges and probabilities as a series of coordinates describing only points on the probability graph at which significant changes in probabilities occur. This method will replace the current method that records the probabilities at fixed-range increments. This change will allow more efficient processing of the probability data and will permit MALOS to generate probability-to-kill data from one data set for scenarios designed for different scales.

A library of standard scenario mapsheets, orders of battle (both red and blue), reusable and expendable asset types, task types, numbers of engineer assets available, piece types, and parameters will ultimately be provided for use by scenario designers as starting points for a particular scenario design. These data bases will be scale-dependent, but scenario designers will be able to edit them to satisfy particular demands.

Only one data base for each weapon type and weapons effectiveness data (probability tables) will be available in the library. Data in these bases will be unchangeable since they are not independent of the MALOS driver software. Thus, scenario designers can neither invent new weapons types nor redefine the probabilites to hit and/or kill. Scenario designers can, however, elect to use only a subset of the weapon types available to them.

No attack or defense plans will be stored in the library. The designer of each scenario will create these plans as part of the scenario design process.

Map Editor

A map editor module will be designed to help scenario designers create and modify maps more easily than is now possible. In OPS 1.1, the map creation process is laborious and requires the designer to specify individually the type of terrain to be assigned to each of 1800 map cells. The improved map editor will allow designers to assign a certain terrain type to a map area by specifying the terrain type to be assigned and then moving the cursor around on the map sheet. Road trace definition will be done similarly, and the map editor will use a simple assignment algorithm to assign a certain road symbol to a particular map cell. For example, if the road trace is drawn through a wooded area, the map editor would assign a symbol of a "road in woods." It would also decide the correct road intersection symbol to be shown. The designer would then edit the road trace to the specific design.

Scenario Assembler

A scenario assembler/editor is needed that will enable a scenario designer to create space for a new scenario, delete old scenarios, and create and name a new scenario from data in the MALOS library.

Access Control

An access system is needed to control who can do what in creating/deleting/editing maps and scenarios. The access system will have one or more directors who will have full access to all features of the map/scenario generation system, i.e., they will be able to create, edit, delete any data base in any of the libraries and assign which features of the scenario/map generation system will be available to all other system users. When a user, to whom the director has given map create/edit capabilities, creates a map, he/she will be able to specify who will be able to edit/delete that map. The director(s) will have override authority and will be able to edit or delete any map or scenario.

Statistical Reports

In addition to the current statistics reported in OPS 1.1, the following statistics would be helpful to lesson designers: amount of blue primary weapons system ammunition destroyed before it could be fired; number of red vehicles destroyed by fire while not engaged by an obstacle; number of red vehicles destroyed by fire while engaged by an obstacle; and number of red vehicles killed by mines. Statistics will be reported by vehicle type and when appropriate, by obstacle type, as well as summary totals.

Scenario Replay

The ability to permit an "instant reply" of a given scenario will be provided by storing the initial state variables and a pseudorandom seed equal to the seed used in a particular scenario. The option to run the scenario in a "step mode," with the player deciding the size of the time increment step, also will be provided, i.e., the player will be able to specify how many fire rounds to run before pausing to let the player (or instructor) analyze what is happening on the screen.

Game Performance Standards

A feature will be provided that will enable scenario designers to do multiple runs of a given scenario automatically and generate means and standard deviations for the enhanced statistical set described above. This will let scenario designers define a baseline standard against which student performance in obstacle placement can be measured.

Calibration

The weapons effectiveness data must be improved to reflect approved probabilities to hit and to kill given a hit for each of the weapons systems. In OPS 1.1, representative data are used and have not been validated. Although the current data will be improved during the model development phase, the data validation and improvement should continue into the operation and maintenance phase. Moreover, since the model is primarily a teaching tool and not an operations research tool, instructors may, in the future, wish to bias the data somewhat to emphasize a particular teaching point.

Troop Deployments

The attack plans and friendly troop deployments programmed into OPS 1.1 were examples only and, in the future, should be modified to reflect more realistic offensive and defensive deployments.

5 CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The OPS 1.1 pilot model has shown that computer simulation is a feasible way of teaching obstacle employment principles. However, pilot model's current capabilities do not include the scenario development infrastructure that instructors need to exploit this tool--that is, to allow them to deliver a particular teaching point. The OPS 1.1 scenario itself can be used in only a limited role in the overall course of instruction. A lesson development "tool kit" is needed to allow instructors to custom-design scenarios in support of specific teaching objectives. A scenario management system also is needed to control the simulation development process.

Recommendations

Based on results of this study, the following steps are recommended for improving OPS 1.1 capabilities:

1. Develop a scenario generation and management system to be used with the MALOS simulation driver that will enable individual instructors to custom-design scenarios easily.

2. Improve the MALOS driver to allow a reasonable range of map scales to be modeled and multiple scenarios to be run.

3. Develop a library of data bases that instructors can use as starting points for their scenario designs.

4. Improve the map editor to allow faster and easier creation of original maps and editing of existing maps.

5. Provide for a wider variety of statistical data to be collected during the simulation run.

6. Develop an enhanced version of MALOS that will allow the player to maneuver blue forces in response to the red attack.

7. Provide a scenario replay capability and an option to make the action pause after so many fire increments have transpired.

8. Evaluate the cost and benefits of developing enhanced versions of MALOS that will permit both red and blue forces to be played interactively. On one end of the spectrum would be a two-player (two-screen) game in which one red player challenges one blue player. On the other end of the spectrum would be a multiplayer game in which "m" red players challenge "n" blue players using "m+n" screens to display the game results. In any of these versions, each player would "see" on the screen only those enemy forces within his/her line of sight, not the entire battlefield situation.

Table 1

Allowable Terrain Types

Code	Elevation	Features
0	ground	clear
1	ground	gully
2	ground	gully
3	ground	gully
4	ground	gully
5	ground	gully
6	ground	gully
7	ground	gully
8	ground	gully
9	ground	gully
10	ground	gully
11	slope	
12	hilltop	clear
13	ground	road, clear
14	ground	road, clear
15	ground	road, clear
16	ground	road, clear
17	ground	road, clear
18	ground	road, clear
19	ground	road, clear
20	ground	road, clear
21	ground	road, clear
22	ground	road, clear
23	ground	road, town
24	ground	woods
25	hilltop	woods
26	hilltop	road, town
27	hilltop	road, woods
28	hilltop	road, woods
29	hilltop	road, clear
30	hilltop	road, clear
31	hilltop	road, clear
32	hilltop	road, clear
33	slope	road
34	slope	road
35	ground	woods, road
36	ground	woods, road
37	ground	woods, road
38	ground	clear, ford
39	ground	clear, ford
40	ground	woods, road
41	ground	swamp
42	ground	road, swamp
43	ground	road, swamp
44	ground	gully, woods
45	ground	gully, woods
46	ground	ford, woods
47	ground	ford, woods
48	ground	ford, woods
49	ground	ford, woods
50	hilltop	clear, road
51	hilltop	clear, road
52	hilltop	clear, road
53	hilltop	clear, road
54	hilltop	clear, road
55	hilltop	clear, road
56	ground	water
57	ground	woods, road
58	ground	woods, road
59	ground	road, bridge, clear, water
60	ground	road, bridge, clear, water

Table 2

Graphic Terrain Symbols by Code Number

1	"[illegible]"	21	"[illegible]"	41	"[illegible]"
2	"[illegible]"	22	"[illegible]"	42	"[illegible]"
3	"[illegible]"	23	"[illegible]"	43	"[illegible]"
4	"[illegible]"	24	"[illegible]"	44	"[illegible]"
5	"[illegible]"	25	"[illegible]"	45	"[illegible]"
6	"[illegible]"	26	"[illegible]"	46	"[illegible]"
7	"[illegible]"	27	"[illegible]"	47	"[illegible]"
8	"[illegible]"	28	"[illegible]"	48	"[illegible]"
9	"[illegible]"	29	"[illegible]"	49	"[illegible]"
10	"[illegible]"	30	"[illegible]"	50	"[illegible]"
11	"[illegible]"	31	"[illegible]"	51	"[illegible]"
12	"[illegible]"	32	"[illegible]"	52	"[illegible]"
13	"[illegible]"	33	"[illegible]"	53	"[illegible]"
14	"[illegible]"	34	"[illegible]"	54	"[illegible]"
15	"[illegible]"	35	"[illegible]"	55	"[illegible]"
16	"[illegible]"	36	"[illegible]"	56	"[illegible]"
17	"[illegible]"	37	"[illegible]"	57	"[illegible]"
18	"[illegible]"	38	"[illegible]"	58	"[illegible]"
19	"[illegible]"	39	"[illegible]"	59	"[illegible]"
20	"[illegible]"	40	"[illegible]"	60	"[illegible]"

Table 3

Movement Factor Chart

Movement Factor	Clock Increment 1	2	3	4	5	6	7	8	9	10	11	12
12	X	X	X	X	X	X	X	X	X	X	X	X
11	X	X	X	X	X	.	X	X	X	X	X	X
10	X	X	X	X	X	.	X	X	X	X	X	.
9	X	X	X	.	X	X	X	.	X	X	X	.
8	X	X	.	X	X	.	X	X	.	X	X	.
7	X	X	.	X	.	X	.	X	X	.	X	.
6	.	X	.	X	.	X	.	X	.	X	.	X
5	.	X	.	X	.	.	X	.	X	.	.	X
4	.	.	X	.	.	X	.	.	X	.	.	X
3	.	.	.	X	.	.	.	X	.	.	.	X
2	.	.	.	.	.	X	.	.	.	.	.	X
1	.	.	.	.	.	X	.	.	.	.	.	.
0	.	.	.	.	.	.	.	.	.	.	.	.

Table 4

Movement Costs for Vehicles in OPS 1.1

FROM \ TO	Ground	Slope	Hilltop	Clear	Woods	Road	Bridge	Town	Gully	Swamp	Ford	Water
Ground		5	X	–	–	–	–	–	–	–	–	–
Slope	–	5	4	2	3	–	–	2	3	3	3	11
Hilltop	X	3	–	–	–	–	X	–	X	X	X	X
Clear	–	3	–	1	2	–	–	1	2	2	2	11
Woods	–	5	–	2	5	–	2	2	3	3	3	11
Road	–	–	–	–	–	0	0	–	–	–	–	–
Bridge	–	–	–	1	2	0	0	–	X	–	–	–
Town	–	3	–	1	2	–	–	–	2	2	2	11
Gully	–	11	X	11	9	–	X	11	4	11	3	11
Swamp	X	X	X	X	X	–	X	X	X	X	X	X
Ford	2	5	X	2	2		–	2	2	2	2	11
Water	–	11	X	11	11	–	X	11	11	11	11	11

"–" means such a move is irrelevant
"X" means such a move is not allowed

Table 5

Engineer Reusable Assets Defined for OPS 1.1

Code	Display Description	Feature	Explanation
ces	Engineer Squads		
ace	M9 ACE	Blade	ACE=Armored Combat Earthmover
cev	M728 CEV	Blade	CEV=Combat Engineer Vehicle
ebl	Bucket Loader	Blade	
see	Sm. Empl. Excavator	Blade	
gemss	M128 Mine Layer		

Table 6

Engineer Expendable Assets Defined for OPS 1.1

Code	Display Description	Explanation
m15atm	M15 AT mines	AT=Anti-tank
m75atm	M75 GEMSS minefield	Ground Emplaced Mine Scattering System
raams	RAAMS volleys	volley: six gun battery
m180	M180 Kit	Road cratering system
sc40	Shape Charge (40lb)	
cc40	Crater Charge (40lb)	
tnt	TNT	In pounds

Table 7

Engineer Task Types Defined for OPS 1.1

Task Code	Task Description
mfj	One 200m x 50m conventional, 1-0-0 density minefield
mfg	Four 200m x 50m GEMMS emplaced 1-0-0 density minefields
mfa	One 200m long RAAMS emplaced 1-0-0 density minefield
atd	One 200m long anti-tank ditch
brb	Demolish one primary two-lane highway bridge
rcm	One relieved face road crater, 30 ft x 18 ft
aam	One abatis, 75m long
urr	One urban rubble obstacle, 100 ft long, two sides
fp	Two each fighting positions for each of two venicles

Table 8

Engineer Asset Requirements per Task for OPS 1.1

Asset Code	Task Codes mfj	*mfg	mfa	atd	brb	rcm	aam	urr	fp
ces	3	1			1	1	1	4	
ace				2					
gemss		1							
(blade)									1
m15atm	222								
m75atm		800							
raams			6						
m180						5			
sc40					5				
cc40					5				
tnt					160		100	850	

*Distributed over 4 map cells, same or adjacent

Table 9

Total Engineer Assets Used for OPS 1.1

Expendable Asset Code	Number Of Units	Renewable Asset Code	Number Of Units
m15atm	2000	ces	9
m75atm	3200	ace	6
m180	100	cev	2
sc40	125	ebl	1
cc40	70	see	2
tnt	15000	gemss	1
raams	18		

********************************* Weapon: BLUE TOW *********************

Range(m):	200	400	600	800	1000	1200
P(hit),open:	20	60	60	60	60	60
P(kill) target in open, given hit:						
trgt:T64	100	85	85	85	85	85
trgt:BMP	100	85	85	85	85	85
trgt:BTR60	100	85	85	85	85	85
P(h),defilade:	10	40	40	40	40	40
P(kill) target in defilade, given hit:						
trgt:T64	100	50	50	50	50	50
trgt:BMP	100	63	63	63	63	63
trgt:BTR60	100	63	63	63	63	63

********************************* Weapon: BLUE 105mm ******************

Range(m):	200	400	600	800	1000	1200
P(hit),open:	50	50	50	45	40	35
P(kill) target in open, given hit:						
trgt:T64	100	90	80	78	75	71
trgt:BMP	100	100	100	100	100	100
trgt:BTR60	100	100	100	100	100	100
P(h),defilade:	40	35	30	25	20	15
P(kill) target in defilade, given hit:						
trgt:T64	100	85	83	80	75	67
trgt:BMP	100	100	100	100	100	100
trgt:BTR60	100	100	100	100	100	100

********************************* Weapon: BLUE 25mm ******************

range(m)	200	400	600	800	1000
P(hit),open:	40	20	10	5	5
P(kill) target in open, given hit:					
trgt:T64	3	0	0	0	0
trgt:BMP	25	25	25	20	15
trgt:BTR60	25	25	25	20	15
P(h),defilade:	6	4	3	2	1
P(kill) target in defilade, given hit:					
trgt:T64	0	0	0	0	0
trgt:BMP	3	0	0	0	0
trgt:BTR60	3	0	0	0	0

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Table 10

Blue Weapon Probability Values Used in OPS 1.1

apon: BLUE TOW **

	600	800	1000	1200	1400	1600	1800	2000	2200
	60	60	60	60	60	60	60	60	55
	85	85	85	85	85	85	85	85	85
	85	85	85	85	85	85	85	85	85
	85	85	85	85	85	85	85	85	85
	40	40	40	40	40	40	40	40	35
it:									
	50	50	50	50	50	50	50	50	50
	63	63	63	63	63	63	63	63	63
	63	63	63	63	63	63	63	63	63

apon: BLUE 105mm **

	600	800	1000	1200	1400	1600	1800	2000	2200
	50	45	40	35	30	30	25	20	15
	80	78	75	71	67	67	60	50	33
	100	100	100	100	100	100	100	100	100
	100	100	100	100	100	100	100	100	100
	30	25	20	15	10	10	5	5	
t:									
	83	80	75	67	50	50	20	20	
	100	100	100	100	100	100	100	100	
	100	100	100	100	100	100	100	100	

apon: BLUE 25mm **

	600	800	1000
	10	5	5
	0	0	0
	25	20	15
	25	20	15
	3	2	1
it:			
	0	0	0
	0	0	0
	0	0	0

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af 3

1.1

2200	2400	2600	2800	3000	3200	3400	3600
55	50	50	50	50	45	40	40
85	85	85	85	85	85	85	85
85	85	85	85	85	85	85	85
85	85	85	85	85	85	85	85
35	30	30	30	30	30	30	30
50	50	50	50	33	33	20	15
63	63	63	63	50	33	33	33
63	63	63	63	50	33	33	33

2200	2400	2600	2800	3000	3200	3400	3600
15	10	5					
33	30	15					
100	50	50					
100	50	50					

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Blue

*************************** Weapon: BLUE TOW ***************************

Range(m):	200	400	600	800	1000	1200	140
P(kill),target in open:							
trgt:T64	20	51	51	51	51	51	5
trgt: BM	20	51	51	51	51	51	5
trgt:BTR	20	51	51	51	51	51	5
P(kill),target in defilade:							
trgt:T64	10	20	20	20	20	20	2
trgt:BMP	10	25.2	25.2	25.2	25.2	25.2	25.
trgt:BTR	10	25.2	25.2	25.2	25.2	25.2	25.

*************************** Weapon: BLUE 105mm ***************************

Range(m):	200	400	600	800	1000	1200	140
P(kill),target in open:							
trgt:T64	50	45	40	35.1	30	24.85	20.
trgt:BMP	50	50	50	45	40	35	3
trgt:BTR	50	50	50	45	40	35	3
P(kill),target in defilade:							
trgt:T64	40	29.75	24.9	20	15	10.05	
trgt:BMP	40	35	30	25	20	15	
trgt:BTR	40	35	30	25	20	15	1

*************************** Weapon: BLUE 25mm ***************************

Range(m):	200	400	600	800	1000
P(kill),target in open:					
trgt:T64	1.2	0	0	0	0
trgt:BMP	10	5	2.5	1	.75
trgt:BTR	10	5	2.5	1	.75
P(kill),target in defilade:					
trgt:T64	0	0	0	0	0
trgt:BMP	.18	0	0	0	0
trgt:BTR	.18	0	0	0	0

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Table 11

Blue Fire Kill Probabilities Computed by MALOS

1000	1200	1400	1600	1800	2000	2200	2400	260
51	51	51	51	51	51	46.75	42.5	42.
51	51	51	51	51	51	46.75	42.5	42.
51	51	51	51	51	51	46.75	42.5	42.
20	20	20	20	20	20	17.5	15	1
25.2	25.2	25.2	25.2	25.2	25.2	22.05	18.9	18.
25.2	25.2	25.2	25.2	25.2	25.2	22.05	18.9	18.

1000	1200	1400	1600	1800	2000	2200	2400	260
30	24.85	20.1	20.1	15	10	4.95	3	.7
40	35	30	30	25	20	15	5	2.
40	35	30	30	25	20	15	5	2.
15	10.05	5	5	1	1			
20	15	10	10	5	5			
20	15	10	10	5	5			

1000
0
.75
.75
0
0
0

1 of 3

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2400	2600	2800	3000	3200	3400	3600
42.5	42.5	42.5	42.5	38.25	34	34
42.5	42.5	42.5	42.5	38.25	34	34
42.5	42.5	42.5	42.5	38.25	34	34
15	15	15	9.9	9.9	6	4.5
18.9	18.9	18.9	15	9.9	9.9	9.9
18.9	18.9	18.9	15	9.9	9.9	9.9

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2400	2600
3	.75
5	2.5
5	2.5

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Table 12

Red Weapon Probability Values Used in OPS 1.1

Weapon: RED AT3

range(m)	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
P(hit),open:	60	50	50	50	50	50	50	50	40	30	25	20	20
P(kill) target in open, given hit:													
trgt:M1	50	50	50	50	50	50	50	50	50	50	50	50	50
trgt:M2	88	60	60	60	60	60	60	60	60	60	60	60	60
trgt:ITV	88	60	60	60	60	60	60	60	60	60	60	60	60
P(h),defilade:	40	30	30	30	30	30	30	30	20	10	5	5	5
P(kill) target in defilade, given hit:													
trgt:M1	50	50	50	50	33	33	33	33	25	25	25	10	10
trgt:M2	50	50	50	50	33	33	33	33	25	25	25	10	10
trgt:ITV	50	50	50	50	33	33	33	33	25	25	25	10	10

Weapon: RED 125mm

Range(m):	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
p(h),open:	60	50	50	45	40	35	30	30	25	20	15	10	5
P(kill) target in open, given hit:													
trgt:M1	67	60	60	55	55	55	50	33	33	25	25	10	10
trgt:M2	83	80	80	78	75	71	67	67	60	50	33	33	20
trgt:ITV	83	80	80	78	75	71	67	67	60	50	33	33	10
P(h),defilade:	30	30	30	25	25	20	15	15	10	10			
P(kill) target in defilade, given hit:													
trgt:M1	67	67	67	60	60	50	33	33	10	10			
trgt:M2	83	83	83	80	80	80	80	80	80	50			
trgt:ITV	83	83	83	80	80	80	80	80	80	50			

Weapon: RED 73mm

Range(m):	200	400	600	800	1000	1200
P(hit),open:	30	25	20	10	5	1
P(kill) target in open, given hit:						
trgt:M1	67	60	50	50	20	10
trgt:M2	83	80	75	60	40	20
trgt:ITV	83	80	75	60	40	20
P(h),defilade:	25	20	15	5		
P(kill) target in defilade, given hit:						
trgt:M1	40	30	25	10		
trgt:M2	60	60	60	40		
trgt:ITV	60	60	60	40		

Weapon: RED 14.5mm

Range(m):	200	400	600	800	1000
P(hit),open:	40	35	30	25	20
P(kill) target in open, given hit:					
trgt:M1	13	3	3	0	0
trgt:M2	25	15	15	15	15
trgt:ITV	25	15	15	15	15
P(h),defilade:	30	25	20	15	
P(kill) target in defilade, given hit:					
trgt:M1	3	0	0	0	
trgt:M2	15	8	8	8	
trgt:ITV	15	8	8	8	

Weapon: RED 12.7mm

Range(m):	200	400	600	800	1000	1200	1400
P(hit),open:	30	25	20	10	10	5	5
P(kill) target in open, given hit:							
trgt:M1	16	10	5	0	0	0	0
trgt:M2	33	30	25	25	20	10	5
trgt:ITV	33	30	25	25	20	10	5
P(h),defilade:	20	15	10	5	5		
P(kill) target in defilade, given hit:							
trgt:M1	10	10	5	5	0		
trgt:M2	15	15	10	5	5		
trgt:ITV	15	15	10	5	5		

Table 13

Red Fire Kill Probabilities Computed by MALOS

Weapon: RED AT3

Range(m):	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
P(kill),target in open:													
trgt:M1	30	25	25	25	25	25	25	25	20	15	12.5	10	10
trgt:M2	52.8	30	30	30	30	30	30	30	24	18	15	12	12
trgt:ITV	52.8	30	30	30	30	30	30	30	24	18	15	12	12
P(kill),target in defilade:													
trgt:M1	20	15	15	15	9.9	9.9	9.9	9.9	5	2.5	1.25	.5	.5
trgt:M2	20	15	15	15	9.9	9.9	9.9	9.9	5	2.5	1.25	.5	.5
trgt:ITV	20	15	15	15	9.9	9.9	9.9	9.9	5	2.5	1.25	.5	.5

Weapon: RED 125mm

Range(m):	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
P(kill),target in open:													
trgt:M1	40.2	30	30	24.75	22	19.25	15	9.9	8.25	5	3.75	1	.5
trgt:M2	49.8	40	40	35.1	30	24.85	20.1	20.1	15	10	4.95	3.3	1
trgt:ITV	49.8	40	40	35.1	30	24.85	20.1	20.1	15	10	4.95	3.3	1
P(kill),target in defilade:													
trgt:M1	20.1	20.1	20.1	15	15	10	4.95	4.95	1	1			
trgt:M2	24.9	24.9	24.9	20	20	16	12	12	8	5			
trgt"ITV	24.9	24.9	24.9	20	20	16	12	12	8	5			

Weapon: RED 73mm

Range(m):	200	400	600	800	1000	1200
P(kill),target in open:						
trgt:M1	20.1	15	10	5	1	.1
trgt:M2	24.9	20	15	6	2	.2
trgt:ITV	24.9	20	15	6	2	.2
P(kill),target in defilade:						
trgt:M1	10	6	3.75	.5		
trgt:M2	15	12	9	2		
trgt:ITV	15	12	9	2		

Weapon: RED 14.5mm

Range(m):	200	400	600	800	1000
P(kill),target in open:					
trgt:M1	5.2	1.05	.9	0	0
trgt:M2	10	5.25	4.5	3.75	3
trgt:ITV	10	5.25	4.5	3.75	3
P(kill),target in defilade:					
trgt:M1	.9	0	0	0	
trgt:M2	4.5	2	1.6	1.2	
trgt:ITV	4.5	2	1.6	1.2	

Weapon: RED 12.7mm

Range(m):	200	400	600	800	1000	1200	1400
P(kill),target in open:							
trgt:M1	4.8	2.5	1	0	0	0	0
trgt:M2	9.9	7.5	5	2.5	2	.5	.25
trgt:ITV	9.9	7.5	5	2.5	2	.5	.25
P(kill),target in defilade:							
trgt:M1	2	1.5	.5	.25	0		
trgt:M2	3	2.25	1	.25	.25		
trgt:ITV	3	2.25	1	.25	.25		

Table 14

Piece Definition Data

Team:	Blue	Blue	Blue	Red	Red	Red
Piece name:	M1	M2	ITV	T-64	BTR-60	BMP
Primary Weapon:	105mm	TOW	TOW	125mm	14.5mm	AT-3
Secondary Weapon:	none	25mm	none	12.7mm	none	73mm
Primary Basic Load:	55	12	12	40	127	4
Movement Factor:	12	12	12	12	12	12

Table 15

Blue Force Order of Battle

Unit No.	Unit Name	Number of Pieces By Type In Each Discrete Subordinate Unit																			
		M2	M2	M2	M2	M2	M2	M2	M1	M1	M1	M1	M1	M1	M1	ITV	ITV	ITV	ITV	ITV	ITV
116	Co. "Q"	2	2	2	2	2	2	2													
117	Co. "B"	2	2	2	2	2	2	2													
118	Co. "C"	2	2	2	2	2	2	2													
119	Co. "D"	2	2	2	2	2	2	2													
120	Co. "E"	2	2	2	2	2	2	2													
121	Co. "F"	2	2	2	2	2	2	2													
122	Co. "M"								2	2	2	2	2	2	2						
123	Co. "N"								2	2	2	2	2	2	2						
124	Co. "X"															2	2	2	2	2	2
125	Co. "Y"															2	2	2	2	2	2

Table 16

Red Force Order of Battle

Unit No.	Unit Name	Number of Pieces By Type In Each Discrete Subordinate Unit								
		BTR-60	BTR-60	BTR-60	T-64	T-64	T-64	BMP	BMP	BMP
101	Bn. "A"	11	11	11						
102	Bn. "B"	11	11	11						
103	Bn. "C"	11	11	11						
104	Bn. "D"	11	11	11						
105	Bn. "E"	11	11	11						
106	Bn. "F"	11	11	11						
107	Bn. "M"				14	13	13			
108	Bn. "N"				14	13	13			
100	Bn. "O"				14	13	13			
110	Bn. "P"				11	10	10			
111	Bn. "Q"				11	10	10			
112	Bn. "R"				11	10	10			
113	Bn. "X"							11	11	11
114	Bn. "Y"							11	11	11
115	Bn. "Z"							11	11	11

Table 17

End of Battle Kill Statistics for 20 Runs of OPS 1.1

Attack Plan	Level of Engineer Effort	Mean Number Killed, Blue Force ITV	M1	M2	TOTAL	%Change (of Total)	Mean Number Killed, Red Force BMP	BTR-60	T-64	TOTAL	%Change (of Total)
A	0	17	24	60	100	Base	9	198	157	364	Base
	2	15	23	66	104	4	11	198	146	355	-2
	3	15	20	66	101	1	11	198	144	353	-3
	4	15	20	64	99	-1	16	198	153	367	1
B	0	10	27	63	100	Base	6	198	160	365	Base
	2	13	26	60	99	-1	11	198	159	368	1
	3	10	22	59	91	-9	10	198	159	367	1
	4	10	20	57	87	-13	15	198	163	376	3
C	0	13	23	63	99	Base	9	198	157	365	Base
	2	13	23	56	92	-7	11	198	158	368	1
	3	12	20	56	88	-11	11	198	156	365	0
	4	12	20	55	87	-12	16	198	163	378	4
D	0	24	24	67	115	Base	32	198	88	378	Base
	2	23	24	64	111	-3	97	198	103	398	5
	3	19	23	59	101	-12	99	198	117	414	10
	4	18	23	59	101	-12	99	198	122	419	11
E	0	24	28	83	135	Base	71	198	117	386	Base
	2	24	28	82	133	-1	75	198	114	387	0
	3	23	26	74	123	-9	78	198	136	413	7
	4	15	23	66	105	-22	84	198	158	440	14

Table 18

End of Battle Survivor Statistics for 20 Runs of OPS 1.1

Attack Plan	Level of Engineer Effort	Blue Force: ITV	Blue Force: M1	Blue Force: M2	Blue Force: TOTAL	Blue Force: %Change (of Total)	Red Force: BMP	Red Force: BTR-60	Red Force: T-64	Red Force: TOTAL	Red Force: %Change (of Total)
		Mean Number of Survivors, Blue Force					Mean Number of Survivors, Red Force				
A	0	7	4	24	36	Base	90	0	56	146	Base
	2	9	5	18	32	-11	88	0	67	155	6
	3	9	8	18	35	-3	88	0	69	157	8
	4	9	8	20	37	3	83	0	60	143	-2
B	0	13	1	21	36	Base	93	0	53	145	Base
	2	11	2	24	37	3	88	0	54	142	-2
	3	14	6	25	45	25	89	0	54	143	-1
	4	14	8	27	49	36	84	0	50	134	-8
C	0	11	5	21	37	Base	90	0	56	145	Base
	2	11	5	28	44	19	88	0	55	142	-2
	3	12	8	28	48	30	88	0	57	145	0
	4	12	8	29	49	32	83	0	50	132	-9
D	0	0	4	17	21	Base	7	0	125	132	Base
	2	1	4	20	25	19	2	0	110	112	-15
	3	5	5	25	35	67	0	0	96	96	-27
	4	6	5	25	35	67	0	0	91	91	-31
E	0	0	0	1	1		28	0	96	124	
	2	0	0	2	3		24	0	99	123	
	3	1	2	10	13		21	0	77	97	
	4	9	5	18	31		15	0	55	70	

Table 19

Standard Deviations for Numbers Killed and Survived

Attack Plan	Level of Engineer Effort	Blue Force Standard Deviations				Red Force Standard Deviations			
		ITV	M1	M2	TOTAL	BMP	BTR-60	T-64	TOTAL
A	0	2	2	4	6	3	0	6	8
	2	2	2	3	5	4	0	10	12
	3	1	1	2	2	4	0	10	12
	4	1	0	4	4	7	0	9	13
B	0	3	1	3	6	3	0	6	8
	2	3	1	3	6	7	0	8	11
	3	2	0	2	4	8	0	7	12
	4	2	0	2	3	10	0	6	14
C	0	1	1	5	6	3	0	6	8
	2	2	1	4	6	4	0	8	10
	3	0	0	3	3	3	0	7	8
	4	1	0	2	2	8	0	6	13
D	0	0	0	3	4	7	0	10	13
	2	1	1	3	4	6	0	12	16
	3	3	1	3	7	0	0	9	9
	4	4	1	3	7	0	0	10	10
E	0	0	1	2	3	7	0	12	17
	2	1	0	3	5	5	0	13	16
	3	2	1	3	5	6	0	10	13
	4	5	1	5	10	7	0	8	13

Table 20

Mean Run Times and Standard Deviation of 20 Runs

Attack Plan	Levels of Engineer Effort	Mean Simulation Time (Seconds)	%change	Standard Deviation (Seconds)
A	0	4344	Base	0
	2	5089	17	5
	3	5088	17	2
	4	5096	17	36
B	0	4152	Base	0
	2	4960	19	30
	3	4988	20	39
	4	4968	20	94
C	0	4344	Base	0
	2	5088	17	0
	3	5088	17	0
	4	5094	17	27
D	0	3432	Base	0
	2	4886	42	27
	3	4908	43	42
	4	4895	43	29
E	0	3765	Base	426
	2	5257	40	211
	3	5439	44	105
	4	5437	44	133

Table 21

Standards for Judging Efficiency of Engineer Effort

Attack Plan	Max Blue Killed If Engineer Effort Is Significant			Min Red Killed If Engineer Effort Is Significant		
	ITV	M1	M2	BMP	BTR-60	T-64
A	13	20	51	16	198	170
B	3	25	56	13	198	173
C	11	21	52	16	198	170
D	24	24	60	108	198	110
E	24	26	79	87	198	144

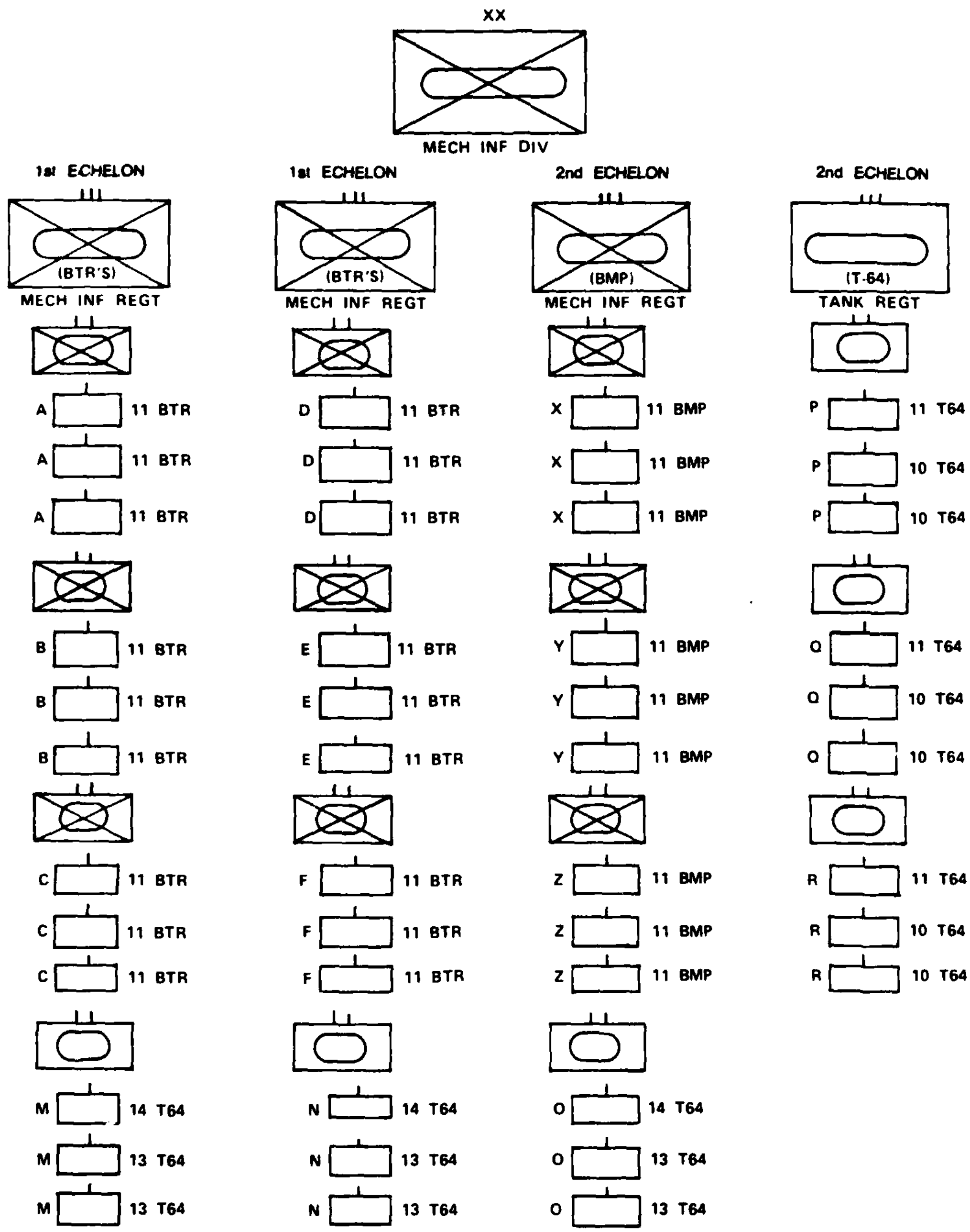

Figure 1. Enemy force organization for combat.

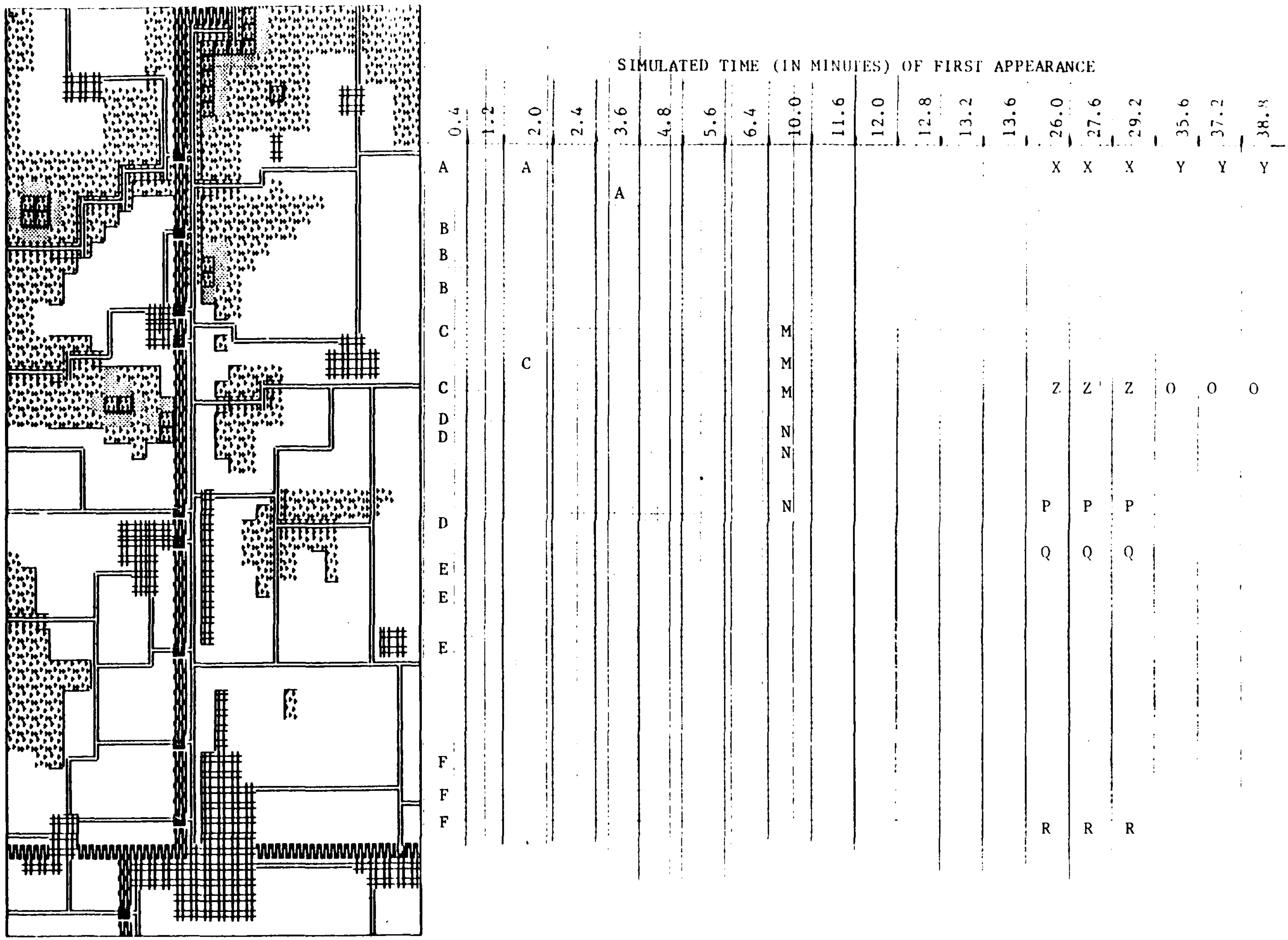

Figure 2. Enemy attack formation "A."

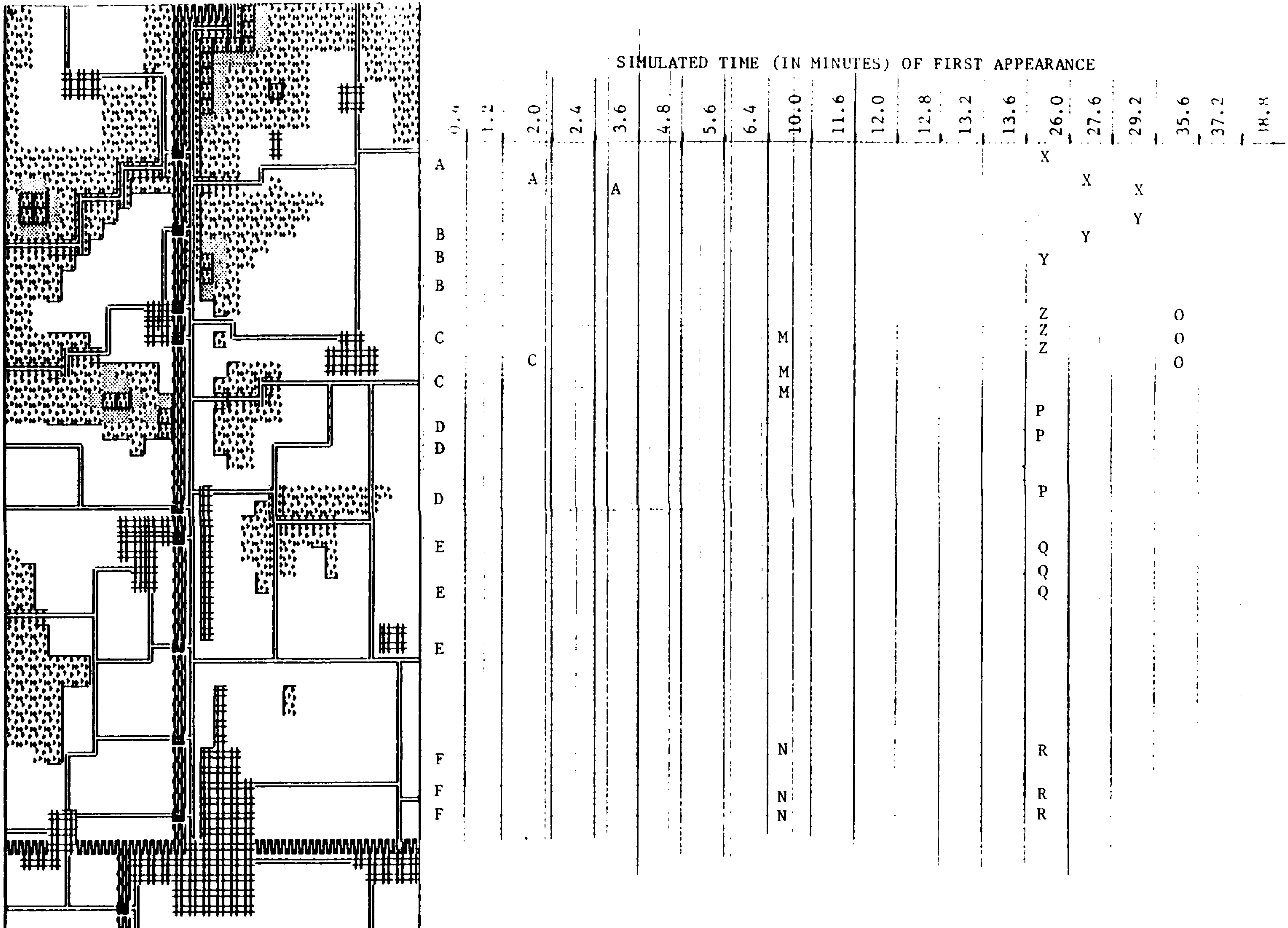

Figure 3. Enemy attack formation "B."

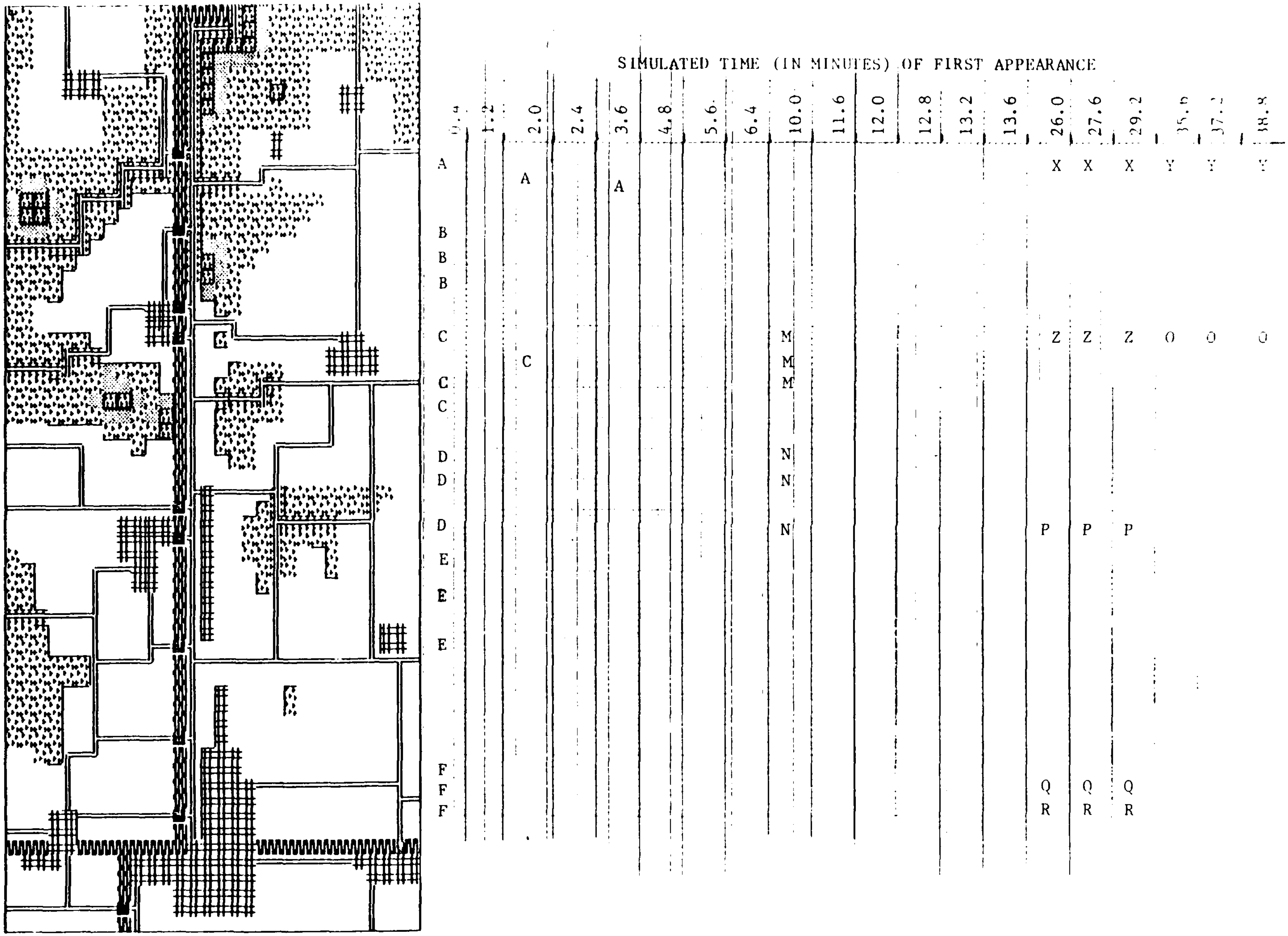

Figure 4. Enemy attack formation "C."

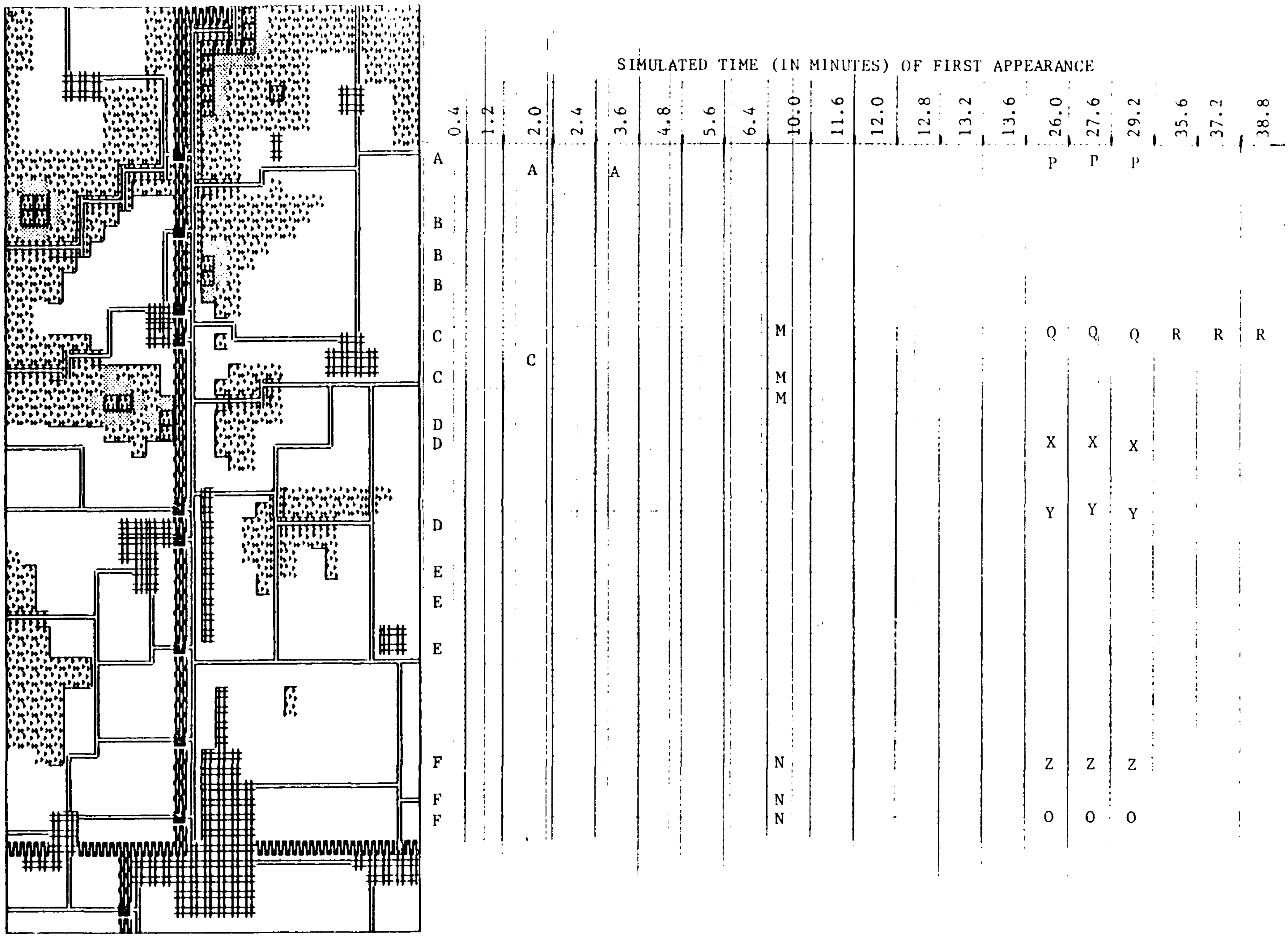

Figure 5. Enemy attack formation "D."

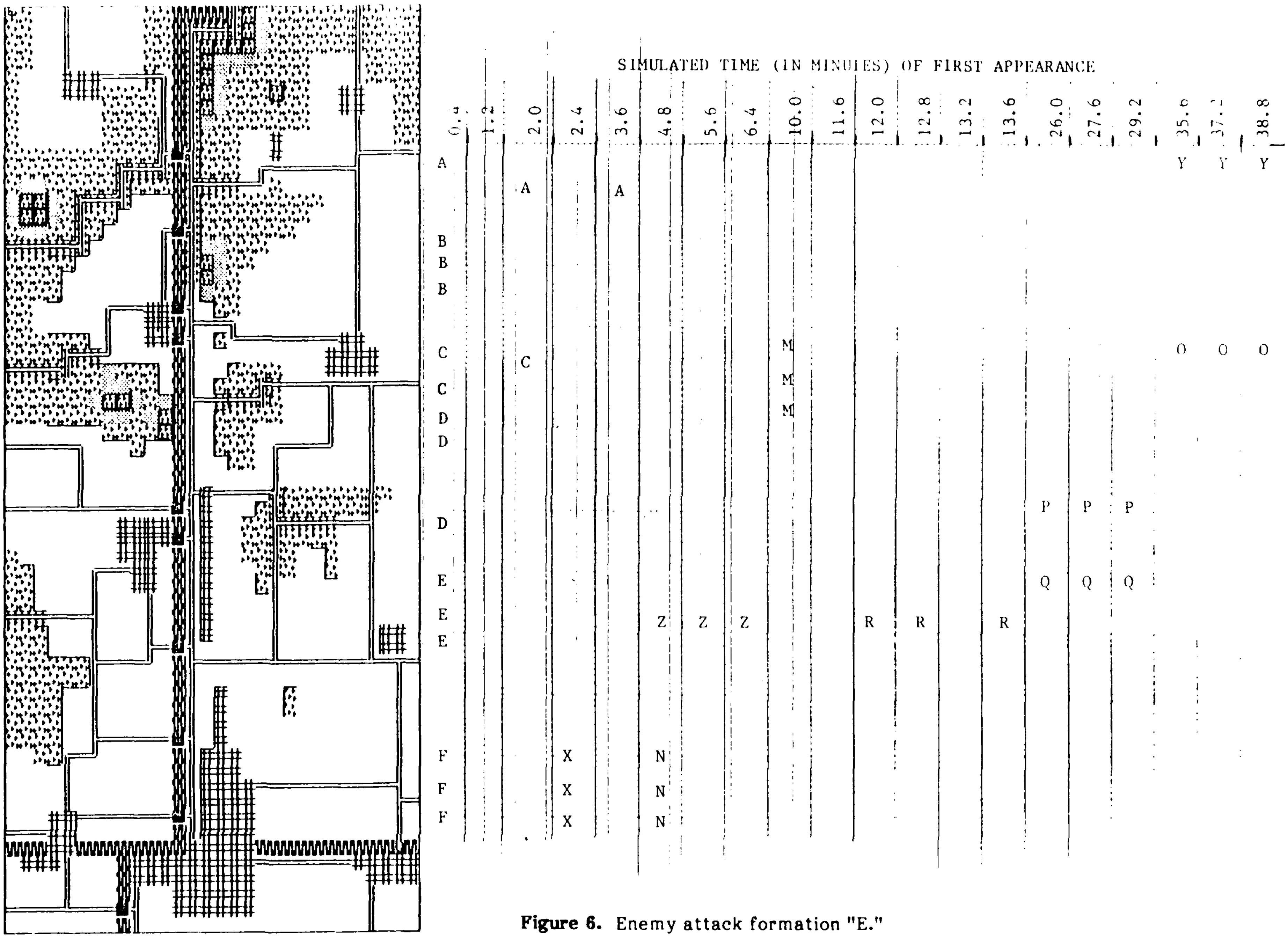

Figure 6. Enemy attack formation "E."

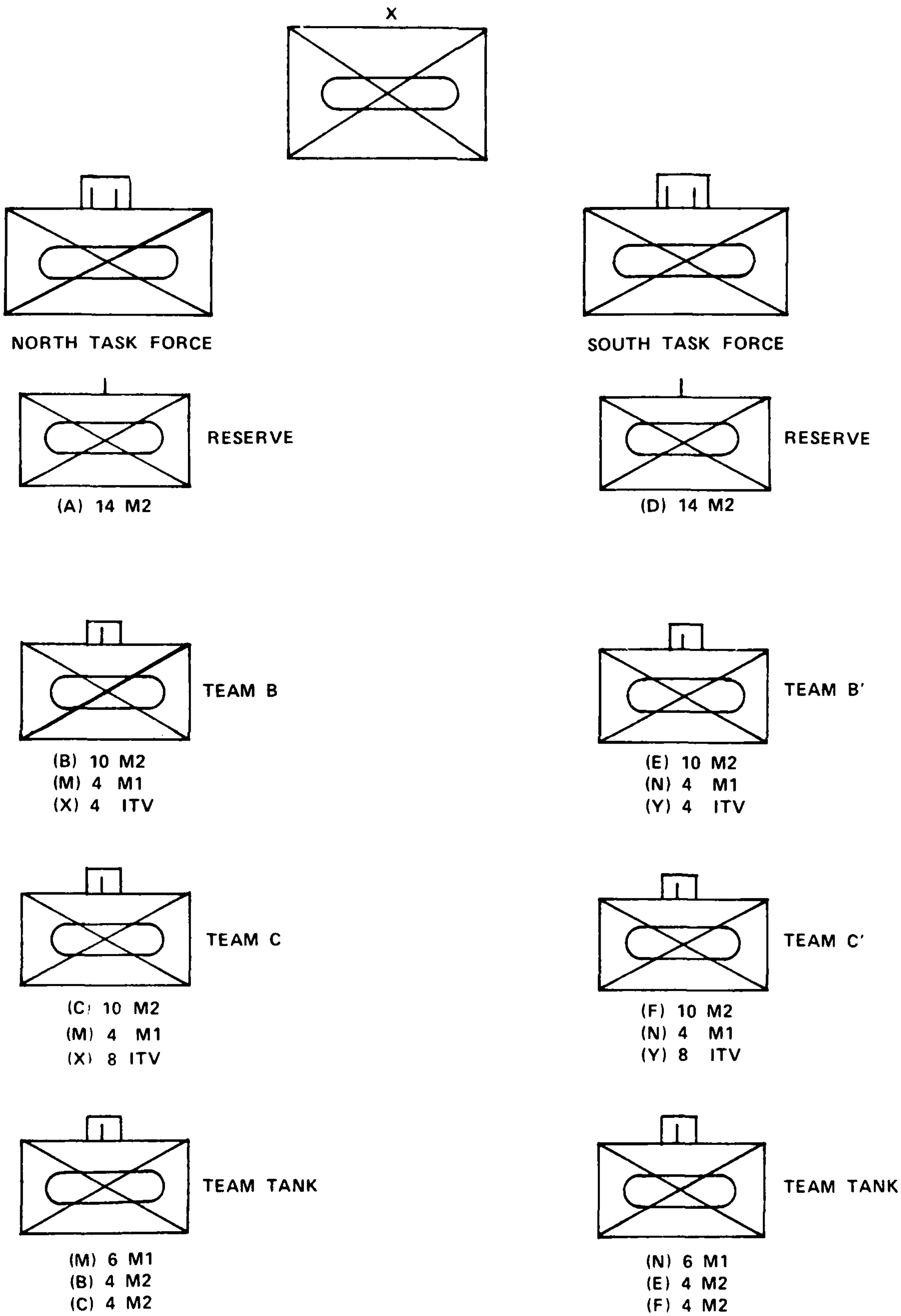

Figure 7. Friendly force organization for combat.

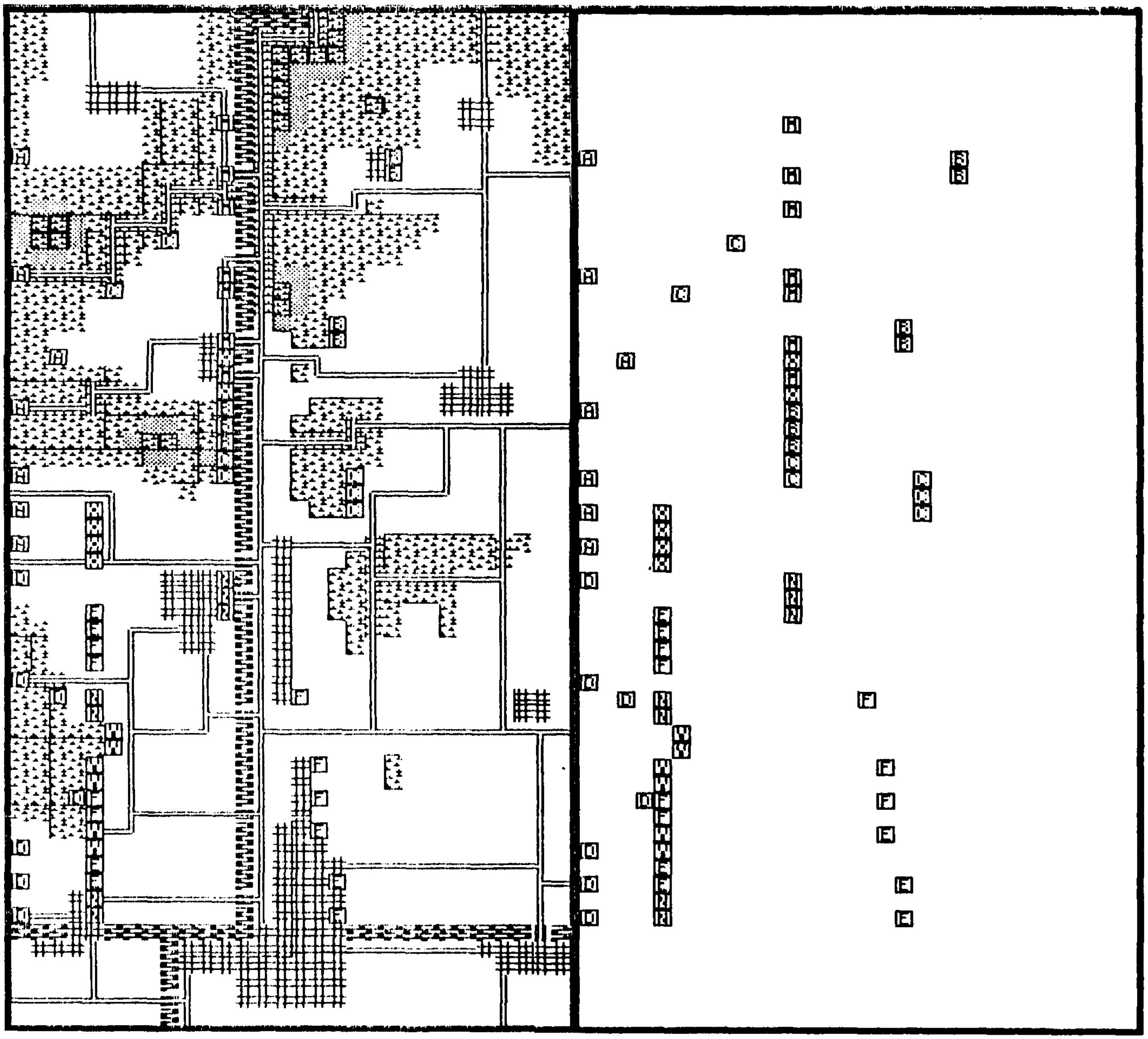

Figure 8. Friendly force deployment for combat.

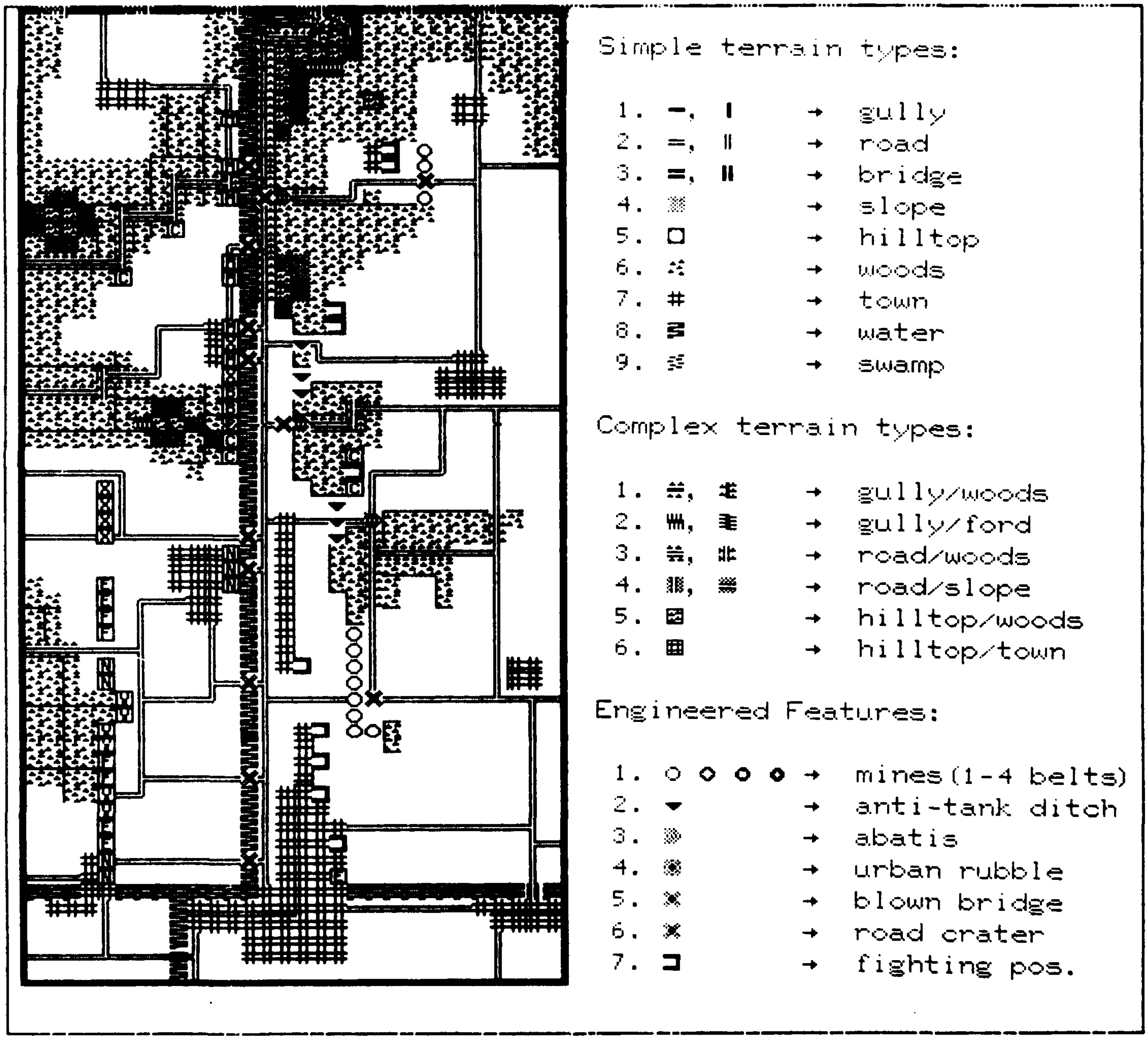

Figure 9. Engineer barriers and fortifications, Level 2.

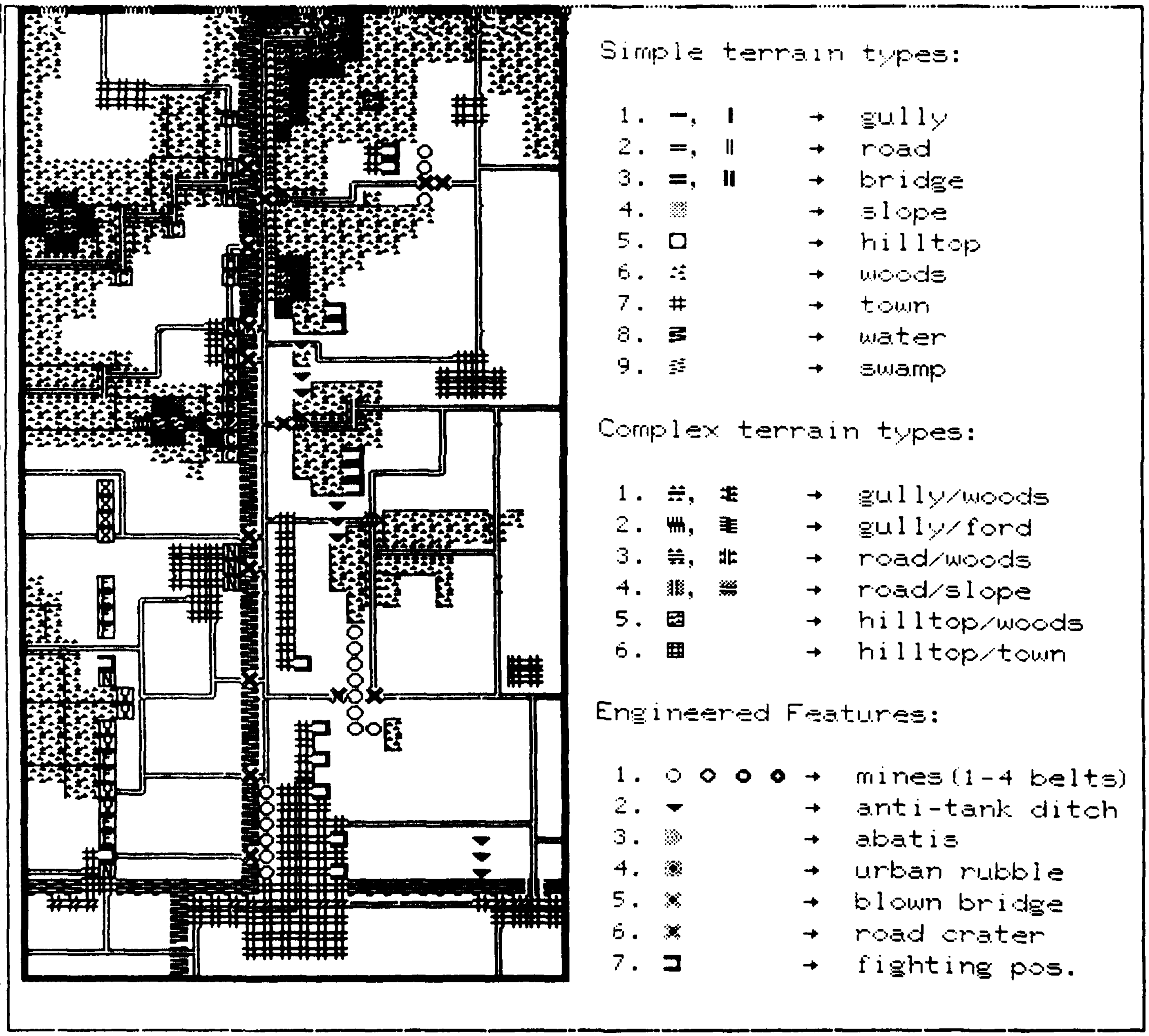

Figure 10. Engineer barriers and fortifications, Level 3.

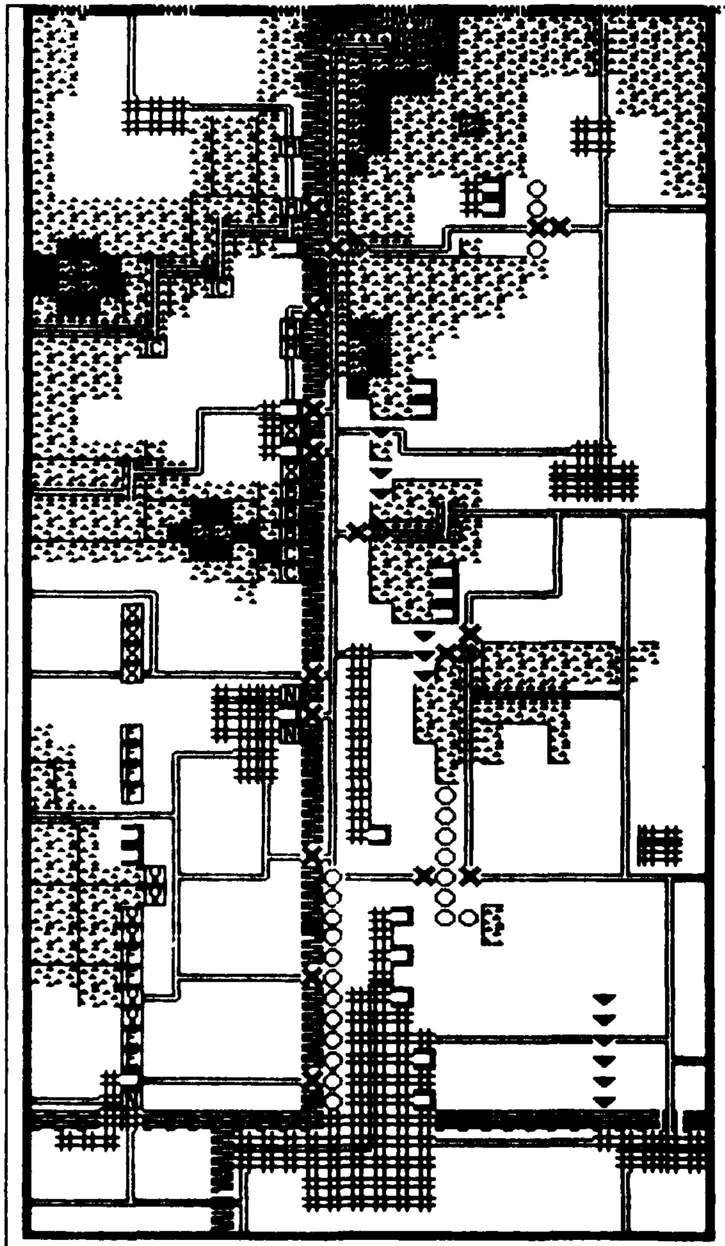

Figure 11. Barriers and fortifications, Level 4.

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